others can provide for themselves except in emergencies, and that those who are indigent must be provided for. The problem is to take care of men, women, and families of the American type who have modest incomes, but who recognize the desirability of getting first-class medical care when they are ill. It is a difficult thing to pick out just what economic levels should be covered. A purely artificial standard of an income of $3000 a year has been chosen as a ceiling. This is in no way stable in the changing conditions of war, with the rapid variations in the cost of living. It does, though, provide a basis for experimentation.

### CALIFORNIA PHYSICIANS' SERVICE

It is most significant that when this California Physicians' Service was offered by the profession to the public there was no crowding the doors to get in. It soon became evident that it was quite a different thing to discuss the desirability of good medical care, from seeking such care when it took the form of insurance against an uncertain future. It was clear that, just as in life insurance, the idea had to be sold, groups had to be educated, and possibilities had to be developed. This meant that growth would be slow and along lines that permitted steady and constant change. The fear that we might be engulfed by too many applicants was very promptly dissipated.

We have had, though, a steady growth in numbers, and are finding ourselves on surer foundations every day. On March 31, 1942, we had the professional membership of 5,300; beneficiary members totaled 40,123; and we had a monthly income of approximately $60,000, and an administrative expense of about $11,000 per month. We are offering several different contracts, varying from a 2-visit deductible contract, a surgical contract, and a rural health program to a relationship to the war industries through the Federal Housing Authority.

Throughout our whole experience we have had the constant and sincere help of the vast majority of the profession. We are in a position to go forward from here more rapidly than ever before. In these changing times no one can say just what will eventuate, but certainly here in California we are better prepared to meet social changes, and to maintain proper relationships between patients and doctors, than in any other part of the nation.

### SOME OF THE DIFFICULTIES

Naturally there have been many difficulties in trying to devise plans to provide adequate payment for professional services. The dues have been put on a minimum basis, and for the class of patient accepted there always has been much free or partially free service rendered by the physician. In individual instances advantage has been taken of the physicians by those who could make ordinary payments for service. Adjustments are being made and rearrangements planned to meet these inadequacies. The fortunate thing is that we are able to make such adjustments among ourselves, and that this is a project of the physicians. If this program had been set up by legislation, then such adjustments would have been of an arbitrary character and difficult to mold and change.

### OUR SPECIAL RESPONSIBILITIES

It seems to me that our main responsibility is to be patient, and to continue to work together for the best solution possible, even under these war conditions. The profession is in for a considerable period of service with the armed forces. In this period there will be many changes. There will be many calls for medical service that may lead to social changes of a far-reaching sort while many of the profession are absent. I believe that one of the very best ways to secure a firm basis for the profession in handling its own affairs in the State is to work as earnestly as possible to use the *California Physicians' Service* as a basis for those reorganizations of medical care that are inevitable in practically every part of California. As the number of physicians and nurses in any community is reduced, we can, through the *California Physicians' Service,* organize centers where members of the profession can provide service on a reasonable prepayment plan to the advantage of everyone. In all of this the *California Physicians' Service* can assist in organization and administration, but the County Medical Society will be needed in order to provide the necessary service on a basis that will assure prompt attention and the greatest economy of time for the physician and all of his assistants.

The war will put our social experiment under heavy strains before it has been completely seasoned. It is still a fragile plant, that needs to be nourished and protected by the profession. If all of us unite, however, in its protection and promotion, we will, I think, have set the ways along which medicine will advance in the years just ahead.

Office of the President.

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## CAN THE HUMAN BODY KEEP PACE WITH THE AIRPLANE?*

David A. Myers, M. D., Lt. Col., M.C., U.S.A.
*San Francisco*

THE entire world is in the midst of an industrial and military era born of military necessity. Coincident to, and as one of the paramount necessities, is aviation. In the past, new eras commenced with steamboats, with the railroads, and the automobile. Their dawns were marked with misgivings and catastrophies that befogged

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From the office of Former Chief Flight Surgeon, U.S.A. Air Corps.

the popular vision. So in aviation, the heroic recklessness that the hazards of war make necessary, the dramatic daring of pioneers trying their wings beyond the realms of known safety, the foolish adventures of unskilled fliers in obsolete machines, divert public attention from what is really going on in the solid, safe development of aviation and its allied factors. This era does not imply the discarding of old-established means of transportation. It means a sudden extension of the capabilities of man; the power to reach hitherto inaccessible spots unerringly and with great swiftness; a means of leaping geographical boundaries in comfort and safety, and another triumph over all-consuming time.

### NEWNESS OF AVIATION

Aviation is a comparatively new field towards which man has come to direct his energies. It is a hobby for many—bread and butter for many more, and today it is undoubtedly the salvation and relief of a war-torn world. It can and does bring fear, devastation and death as a war instrument. Its progress to its present place in the control of world events has been marked by many hazards, many deaths, many adjustments.

Every era of transportation has produced its own category of human ills, ailments and problems. Each era has eventually furnished new light on the solving of the problems, and produced a larger vision regarding that very essential thing to the progress of mankind—prevention of untoward effects arising from the environment in which we live and function. Mankind has ever sought improved methods of transportation, with ever-increasing speed the ultimate goal. Aviation has brought problems relating to oxygen want, acceleration, eyes, ears, air sickness, unprecedented demands on the special senses, inroads on the nervous system, the cardio-vascular system and the body in general.

Aviation engineers push a plane out on the line and say, "There she is boys. She'll do 500 miles an hour and go to 50,000 feet"; and, be it said to the everlasting credit of the Air Corps, some pilot will step up and say, "All right, let's go." About this time, a serious-looking gentleman, (the boys in the Air Corps call him a Flight Surgeon), steps up and says, "How about going along? I think this crate will do what they say it will, but I am not so sure what will happen to the 'Old Timer' up there in the pilot's seat, and if you fellows are going to continue these flights, I've got to know because I have to take care of 'Old Timer' after he gets back and fix him up so he can go again." So far the engineers have outdistanced the Flight Surgeon. They have built aircraft capable of annihiliating space at any altitude, including the stratosphere. Aviation medicine has not yet arrived at definite conclusions as to what "major overhaul" it is necessary to accomplish in human beings in order that they may operate and accompany, with safety and comfort, these speeding demons.

From the Wrights and Kitty Hawk to the present space-annihilating airplane is a long way in terms of transportation. It is a much longer way in terms of adapting the human body to the change. The fighting airplane is subjecting the human body to conditions heretofore deemed impossible. Unlimited speeds are in the offing. Substratosphere flying is already here; the stratosphere is next.

### THE HUMAN BODY AND AIR ENVIRONMENTS

Can the human body survive and continue to efficiently function in such environments? Frankly, we do not know. It is, therefore, up to those who make a vocation of flying and its allied factors, in conjunction with the medical profession, to solve the human problems confronting both military and commercial aviation in order that man may proceed with safety and comfort, when, where, and how he desires, and that the personnel flying and fighting in our combat ships may return victorious and without physical detriment from their missions.

### AVIATION MEDICINE'S FUNDAMENTAL PRINCIPLE

In order to accomplish this, the Air Corps brought into existence the Flight Surgeon Corps. A Flight Surgeon is a doctor ordered to the Medical Division of the Air Corps, a component part of the Medical Corps of the Army, assigned to the duty of living with, flying with, studying these human birds both in flight and on the ground. The Flight Surgeon Corps is a body of men, both civilian and military, all government-trained at a special school of Aviation Medicine; officers by profession, doctors by education, and fliers by necessity. They are able to draw upon the unlimited store of knowledge possessed by the medical profession in general, trained in specialized examinations, and taught especially to observe the reactions of the human body under stress of flying. These pioneer flying doctors, with the aid of the profession at large, will be able to come to definite conclusions on the human problems of flying. Much experimental and research work is still needed before the present attainable speeds and altitudes are made safe for not only military personnel, but for Mr. Average Citizen. Aviation is a complex task. It has the fineness of art and the exactness of science. The military aviator must perform with the highest efficiency or perish. Therefore he must be selected with great care—physical fitness with high thresholds against stress, combined with stable mental and nervous systems, are essential. The *selection* and *maintenance* of the aviator is the fundamental principle on which aviation medicine is founded.

### PHYSICAL STANDARDS FOR FLYERS

Experience in Military Aeronautical training has demonstrated that not every applicant can meet the requirements of the flying task; although he has been found physically qualified, is a member of an optimum group, and has the essential educational background, he may nevertheless fail in adjustment and performance.

Our present physical standards for military flying are based on past experience of selection and maintainance. It is known that some men with severe physical handicaps, have made excellent pilots. Immediate efficiency and ultimate economy indicate the wisdom of admitting to training only the very best physical material.

*Selection.*—In selection only those individuals who are free from real or potential psychological, physical, and mental conditions, should be chosen. The Air Corps physical examination standards have always been high and tend to select only those individuals who will be specially suited for performing complex tasks in an entirely new environment, the air.

In addition to selection, from the physical standpoint, there must be psychological evaluation. Human behavior, as the result of psychological characteristics, differs in each of us and the determination of that psychological makeup best suited to aviation is essential. Among the essential characteristics are intelligence, memory, learning, habit formation, attention, emotional content, reaction time.

*Intelligence* is the ability to apply past experience to the solution of new situations and problems. Flying is a new situation for a human being, and in order that he may adequately meet the many problems involved, it is essential that he possess a satisfactorily high level of general intelligence. Experience has shown that not all individuals having normal or even superior intelligence make successful military aviators. Learning to pilot an airplane demands an accurate capacity for learning, of a specialized sort. At least normal intelligence should be required, as those with less than this endowment are slow to understand instructions, do not remember and have great difficulty in solving their problems quickly and effectively.

*Memory and Learning.*—To become a military flyer, one must learn a great many things. Normal rapidity of learning, with correct habit formation, are essential. Individuals vary in their capacity to learn. Some learn quickly and forget at once. Others learn slowly, but remember for long periods. The person who learns quickly and retains well the specific instructions required for military aviation will inherently be the best material to select. As the result of learning, our experiences, stored away in our brain, take on meaning resulting in perception of our surroundings and environment, and the ability to estimate quickly all situations. Keen perception is an essential factor in pilot make-up. For instance, in flying you see the ground below, and with experience learn much, and perceive many things that are meaningless to others, such as approximate altitude of the airplane, character of the terrain, direction of the wind, etc.

The speed with which the various maneuvers must be learned and coördinated is definitely related to the speed of the aircraft. The responses of the pilot must be learned so well that they become automatic in nature, and not a routine method of handling the ship's controls. When instruction is poorly learned, or when memory lapses, there cannot be effective response and disaster is in the offing. It is apparent, then, that rapidity of learning and habit formation are necessary factors.

*Attention.*—Learning, memory and attention are very closely related, as are all the psychological factors. Effective learning can only be accomplished when there is undivided attention and concentration on the subject at hand. Fighting aircraft built for maximum performance are equipped with much apparatus controlling the power plant, the flight instruments, the landing gears, the wing flaps, the deicers, the radio, and the propeller controls, and many other essential elements of successful flight. All of these instruments require attention at precisely the moment when indicated, or trouble ensues. Absent-minded, over-concentrating or distractable-minded individuals do not belong in the cockpit of a fighting airplane.

*Emotional Content.* — Emotional stability is essential in the successful military aviator, because he must fly and fight in the air away from all ordinary environment, faced with dangerous situations, his own life and that of his comrades depending on an emotional stability that will permit coördinated reactions with lighting-like rapidity when required. Many of the normal emotions, such as anger, fear, resentment, anxiety, surprise, etc., will retard the thought-processes and interfere with the normal flow of coördinated movements, and unless the pilot has emotional stability and control above the average, he will be preoccupied, inattentive and, therefore, dangerous.

*Reaction Time.*—The regular flow of, and the stability of reaction time are exceedingly important in flying, and have been given much consideration in the selection of prospective fliers. Slow-thinkers and slow-reactors are at a distinct disadvantage in flying. Reaction time and mental processes slow up with age, and the fixed habits of age hinder activity; therefore age occupies a definite place in the selection scheme.

This discussion has considered only a few of the factors regarded essential in selection. The sought-for selection ideal would be a physically sound body, encasing an individual who possessed, in a desirable degree, the psychological traits and factors that would result in proper adjustment and performance in any environment.

Flight Surgeons, in conducting this psycho-psychiatric examination or personality study, have three goals in mind: first, to establish the psychic state of the individual; second, to predict the future of that state; and third, to evaluate its adaptability to the new and unusual environment and experiences of aviation.

*Maintenance.*—Every vocation in life, including aviation, has the ordinary maintenance problems of diet, rest, relaxation, exercise, hygiene and sanitation. Aviation, due to its peculiar environmental factors, has many specific problems found only in aviation.

The following list comprises most of the important maintenance problems that aviation medicine has to deal with:—

1. Oxygen and altitude flying.
2. Altitude sickness, acute and chronic.
3. Effects of speed and sudden accelerations.
4. Blacking out.
5. Flier's belly.
6. Effects of noxious fluids and gases.
7. Effects of glare, cold, heat, light, wind, ventilation, and vibration.
8. Effects of flight on (1) eyes (2) ears.
9. Bends or decompression sickness.
10. Occupational fatigue.
11. Aerial equilibrium and spatial orientation. (Blind flying.)
12. Air sickness.
13. Accidents peculiar to aviation.
14. Aero embolism.
15. Anoxia.
16. Protective flying equipment.
17. The neuroses.
18. The psychoses.
19. Aerial sanitation.
20. Aerial relief in emergencies, civilian and military.

The program time assigned will only permit of briefly discussing a limited number of the more important problems with which aviation medicine is vitally concerned as having a direct bearing on the maintenance problem.

## SOME PROBLEMS OF AVIATION MEDICINE

Many of the problems are intimately related and group discussion will be attempted.

*Altitude sickness, Oxygen and high altitude flying:*

The life of man is dependent, not on the quantity or percentage of oxygen in the atmosphere, but on its pressure. Altitude sickness is a form of asphyxia due to diminished partial pressure of oxygen. Much valuable research work regarding the physiological phenomena of altitude has been accomplished, but as soon as an attempt is made to interpret the phenomena of altitude in terms of their causes, difficulties arise. The reason for contradictory theories is to be found in the complexity of the factors which enter into the environment at high altitudes. Among the climatic variables are the low atmospheric pressure, with its low partial pressure of oxygen, the peculiarities of the sunshine, low temperature and humidity, the high wind, and the electric conditions of the atmosphere and ionization.

It is clearly established that high altitudes or low barometric pressure, when first encountered, interfere with the normal workings of the human machine. Any sudden disturbance of any of the bodily functions is usually manifested by symptoms of illness. The disturbances brought on by change of altitude, the symptoms of which are occasionally so mild, depending upon the altitude, may be entirely overlooked by the unobservant. Mankind differs greatly in the power of adjustment to changes of environment. Hence, it is found that altitude sickness befalls some individuals at a lower, others at a higher altitude, but it is also certain that no one who ascends beyond a certain elevation—the critical line for him—escapes the malady. An elevation of 10,000 feet, or even less, might provoke it in some, others may escape the symptoms up to 14,000 feet, while only a very few, possessed of unusual resisting power, can without distress venture upward to 19,000 feet. The symptoms of altitude sickness depend not only on the nature of the individual and his physical condition, but also on various contingencies, especially on the amount of physical exertion made in ascending.

The symptoms produced in the nervous system by higher altitudes are of the most importance from a performance standpoint. There is dulling of the senses and intellect without the individual being aware of it. Memory is affected early and is finally almost lost. Rational judgment is impaired, resulting in fixed, erroneous ideas, and often in uncontrolled, emotional outbursts. Muscle coördination is much affected. Power over the limbs is lost, the legs begin to paralyze, then the arms, and finally the head. The senses are lost, one by one, hearing being the last to go. Any sense of pain is lost early. Without cause there may be laughter, shouting, singing, tears, or actual violent actions. Always, however, there is present complete and satisfactory confidence regarding everything that is happening. It is desired to stress the following: That while the essential cause of altitude reactions is lack of oxygen (anoxemia), the functional disturbances noted are not merely anoxial, but are largely the expression of a secondary and almost equally important deficiency of carbon dioxide in the blood and the tissues. Deficiency in oxygen induces over-breathing and a resulting deficiency of carbon dioxide. Reduced carbon dioxide in turn causes subnormal respiration, and this in turn increases deficiency in oxygen.

The composition of the atmosphere is uniform below the stratosphere, i.e., approximately 70.000 feet:

| | |
|---|---|
| Oxygen, by volume | 21% |
| Nitrogen, by volume | 78% |
| Inert gases, by volume | 1% |

It is, therefore, apparent that the problem we are confronted with in altitude flying is the maintenance of the positive pressure around the body and in the lungs. This is an engineering problem. From the physical standpoint, the low densities, pressures and temperatures are a serious hindrance, in that special precautions must be taken to allow the human body to survive.

Findings regarding the physiological reactions of man to the several types of anoxemia show clearly that the response to lack of oxygen varies with the rate at which the oxygen is decreased, the degree to which it is reduced, and the length of time it is reduced. The respiratory, circulatory, and blood changes have not been found to be the same in the several methods studied for producing this condition. It seems the reaction of the aviator to the lack of oxygen experienced during high altitude flights is quite different from either the very rapidly-produced anoxemia of nitrogen breathing or the slowly-developed condition of the mountain climber. Because man reacts in a certain way to nitrogen or to mountain living, it is not safe to predict how he will respond to lack of oxygen during high altitude flights. Laboratory results are proven positive only when we subject man to the actual conditions of an altitude flight.

The air forces have the following orders regarding the use of oxygen:

1. All flights of 10,000 feet of over one hour duration.

2. All flights to 15,000 feet regardless of duration.

3. From the ground up when the rate of climb is 2000 feet per minute.

4. At night from the ground up.

*Effects of speed, sudden accelerations, sudden retardations:*

In considering this most important subject, two main factors must be kept in mind: (1) the immediate and the ultimate effect on the body tissues, and (2) the immediate effect from a performance standpoint on the individual. The problems of speed, centrifugal force, sudden accelerations, sudden retardation, etc., are carefully figured out by engineers in order that their finished aircraft may withstand all the stresses it will be subjected to. Then it is turned over to a human being to put it through its paces. You cannot build human beings according to specifications. They are produced and delivered as is. You can design a wing that will not come off or crumple at 600 miles an hour, but we cannot supply a liver, blood or spinal fluid, that will stay in their proper place and continue to function under the imposed conditions. Engineers estimate the ultimate speed at sea level at around 660 miles per hour, and undoubtedly human beings can withstand speeds in excess of it. It's when the aircraft makes turns, banks, and dives that centrifugal and centripetal force will begin to create havoc with the human body. The effects of speed "per se" may be minimized, the effects of changes of rapid motion will cause trouble, how much is yet unknown. Centrifugal force acts away from the center. Centripetal force acts towards the center. Centrifugal force acting on the individual tends to carry him in the original direction he was traveling. Traveling at a high rate of speed and suddenly going into a turn, centrifugal force acts on the flier to carry him in the direction of original travel. He cannot move, being firmly fixed by strapping. The body, however, being made up of much that is fluid and semifluid, and everything contained in the body that is moveable, tends to keep moving in the original direction. This actually does produce temporary unconsciousness ("blacking out"), and it is conceivable that damage may ensure to any of the internal organs and be possible for the brain to be sucked down towards the foramen magnum and result in actual brain injury. The damage incurred is the result of the endeavor of the fluid and semifluid contents of the body to move in the direction of centrifugal force. When a pilot has acting upon him an acceleration of several times that of gravity, there is the same proportionate increase of weight in the pilot himself. Therefore a pilot weighing 180 pounds subjected to an acceleration of 5 G would weigh 940 pounds—the blood column itself becomes heavy, there is interference with the flow to and from the brain, and a "black out" is inevitable. This centrifugal force, applied over a period of 3 to 5 seconds, will result in unconsciousness, a succession of "black outs" short of actual loss of consciousness, will result in a decided impairment of immediate function and an end-result having all the symptoms of extreme fatigue.

Experiments carried out at the Physiological Research Laboratory, Wright Field, Ohio, by Flight Surgeon Lt. Colonel Harry G. Armstrong, M.C., on the centrifugal machine constructed under his supervision, have served to solve the problems of what happens to living tissue when subjected to various accelerations. By means of this equipment animal experimentation was carried out and quite definite conclusions arrived at regarding the limits of human resistance to accelerations.

*"Blacking Out" and Flier's Belly:*

"Blacking out," or temporary unconsciousness of the pilot, first came under the author's personal observation during a tour of duty with a Pursuit Squadron in the Hawaiian Islands, 1923-1926. Pursuit aviation requires much acrobatic flying, either single or in formation, and all the elements of speed, sudden acceleration, banks, turns, diving, pull-outs, etc., are present. Information was hard to obtain since the pilots were loath to admit anything was happening to them while in flight. Their idea was that this was an individual reaction, and not a universal phenomenon. This "blacking out" was reported when coming out of long dives, and to a less extent on sharp banks and turns. It persisted in some cases until the upward flight had traversed several hundred feet. The period varied in individuals. The sequence of events producing this reaction is as follows:

1. Sudden change to dive position with increasing acceleration.

2. Sudden and violent change of direction and position at the end of the dive, in preparation for the upward climb.

3. Sudden and violent change of position and direction, with acceleration going into the upward climb.

This sequence of events takes place in military aviation in nearly all ground attack objectives, air combat, gunnery and dive bombing, etc. The reaction is universally admitted by all who participate. During the downward dive there is an excessive supply of blood drawn from the splanchnic reservoirs to the brain. During the flattening out of the sudden ascent, there is an excessive drainage of blood from the brain to the splanchnic area. Old-time pilots adopt various means to try to overcome this "blacking out." Some cry out as loudly as they can. Some wear tight belts. Some cock their heads sharply to one side. Some fill their lungs and forcibly hold their breath. No matter what they do, however, they all "black out." Unconsciously they are adopting measures in an attempt to prevent the reaction caused by the surge of blood to and from the brain and abdominal areas. Nothing has been found as yet that will prevent the occurrence. Undoubtedly pilots have lost control of their ships in doing dives and vertical banks at speeds. The return to normal is reported by the pilots as "sudden." They were in control of their ships or immediately assumed control upon recovery. This must have been true, the only other alternative being a sufficient altitude to furnish a margin of safety. It was concluded that "blacking out" was a transient phenomenon resulting from the violent disturbances of the blood supply to the brain, coupled with unusual movements of the brain itself produced by sudden changes of the body position at high speeds. What ultimate effect repetition will have on the brain is yet unknown.

*Flier's Belly:*

During the observations made on "blacking out," it became apparent that other physical conditions were arising as the result of this oft-repeated sequence of flying maneuvers. Many pilots eventually arrived at a physical condition which, for want of a better term, the author called "flier's belly." The same causative factors producing "blacking out," while they apparently had no findable lasting effects on the brain and brain tissues, produced a symptom complex definitely referred to the splanchnic area. The appearance of symptoms varied in individuals. The neurotics showed early, the semi-neurotics next, and the stables last. Recoveries were in the reverse order. There was capricious appetite; often a loss of desire to eat. Nausea was observed with actual vomiting, especially in the neurotics. Indefinite pain and distress in the epigastric region were common to all. The circulatory efficiency test (so-called Schneider Index) was usually low, indicating a neuro-circulatory involvement. Restlessness and capricious responses to sensory stimuli were common. The "muscular urge" was great, and fatigue came on quickly and easily. Invariably the pilots attributed their condition to something wrong inside their "belly." X-ray and laboratory findings were negative. Complete removal from participation in pursuit tactics and aerobatics, with correction of any faulty habits, usually sufficed to relieve the symptoms, particularly in the semineurotic and stable individuals. Transfer to slower ships, and routine flying or temporary complete removal from flying, was often necessary.

Whether "flier's belly" is a distinct entity, or merely the cumulative effects of occupational neurosis or staleness, has not been proved. The author believes it is an entity and classifies it as a splanchnic neurosis, induced by occupational acts, eventually resulting in a distinct splanchnic condition which, if progressive, results in the well-recognized staleness arising from digestive and splanchnic disorders. It would appear that, since no lasting symptoms were observed in the brain, but did appear in the splanchnic area, the brain encased in its protective coverings is better able to survive the oft-repeated traumatic acts described than the less-protected abdominal contents. Only time and further research will solve this problem. The author desires to go on record as believing "flier's belly" is a distinct entity.

*Aeroembolism, Bends, Decompression Sickness:*

Armstrong defines aeroembolism as a condition produced by a rapid decrease of pressure below (1) atmosphere, such as may occur in aircraft flights to high altitude, and which is marked by the formation of nitrogen bubbles in the body tissues and fluids. The formation of nitrogen bubbles in the body at high altitudes is the same physical process as causes them in deep-sea divers and compressed-air workers.

The bends occur from compression followed by rapid decompression, while aeroembolism occurs from decompression. Body tissues and fluids are saturated with the atmospheric gases at the prevailing sea-level pressure, and the blood in the lungs takes up and dissolves these gases. Nitrogen take-up is much in excess of oxygen and carbon dioxide, and nearly all of the dissolved oxygen in the blood is consumed by the body tissues while the nitrogen is inert, and is not utilized but remains in the tissues in amounts dependent on the partial pressure of the gas in the lungs; therefore at sea-levels the tissues of the body are always saturated with nitrogen. During altitude flights where the atmospheric pressure is decreased, the nitrogen in the blood is given off in the lungs, and that in the tissues begins to enter the blood stream and, by this dual process, the body attempts to rid itself of the excess nitrogen. If the flight ascent is slow enough nothing happens. If the ascent is fast nitrogen bubbles will form in the blood, and tissues of the body. Tissues having a high-fat content and a poor blood supply are favorable sites for bubble formation. Modern aircraft have reached 56,000 feet, and many have a service ceiling of 35,000 feet. Nitrogen bubbles have been shown in the spinal fluid at 18,000 feet, and in the blood and body tissues at 30,000 feet. A rate of climb in excess of 78 feet per minute will produce the disease, and most modern airplanes can ascend at 2000 feet per minute. The control of these symptoms is simple from a commercial standpoint. Simply don't go high enough or fast enough to get into trouble, and if you do have trouble come down slowly.

What can be done when climbing speeds reach 2000 feet a minute and dive bombing speeds are at terminal velocities, and both are routine daily assignment, has yet to be determined. Pathologic lesions are produced by circulation blocking and the mechanical pressure exerted by the tissue bubbles. Cardio vascular failure, pulmonary edema, local disturbances due to circulation failure may show in any organ of the body or central nervous system. The bubbles in the tissues produce pain in the various body structures by pressure, while the central nervous system lesions are due to stretching and tearing, causing disturbed sensory and motor functions.

*Fatigue—Staleness:*

Occupational fatigue in all the vocations has been given much study by the medical profession, and many improvements and changes vital to the welfare of industry and workers put into effect. Every effort has been made in recent years to surround our aviators, while flying, with all the protection possible, in order that they may function with the least effort and without having to make personal adjustments in an effort to ward off the physical and mental fatigue incident to their environment. Since the early days of flying, the stale and over-flown aviator has been a problem. In no branch of the service is staleness or occupational fatigue so apt to occur as in the air forces, and in no branch is it of more vital importance. The daily tasks of the bomber, combat and interceptor groups are performed under abnormal stress. Handling high-powered aircraft capable of 400 miles an hour, with the resulting vibration, rapid changes of speed and altitude, faced by the danger of "blacking out," and aero-embolism, subjected to intense cold, exposed to enemy anti-aircraft, and enemy aircraft fighters, responsible for the lives and safety of the combat crew, maintaining proper position in close formation flying, forced frequently to do blind flying, is it any wonder that "flying fatigue" is the chief problem of maintenance?

Aviation is still in its infancy. With the passing years there have been astonishing developments, and the end is far in the future. Much has already been accomplished in aiding the human body to survive and live in these unknown and unexplored regions. A vast field for research of the most vital and valuable kind is open for the specialist in Aviation Medicine. The surface has been scarcely scratched. The information gained from medical research in aviation will undoubtedly play a great part in the fundamental construction of equipment to meet all the human requirements of not only military necessity, but the safety, health and comfort of the individual, as viewed from a commercial standpoint.

Presidio of San Francisco.

# INTRAPERITONEAL USE OF THE SULFONAMIDES*

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*San Francisco*

Recently, in various journals, many articles on the intraperitoneal use of the sulfonamides have been published. It has been our observation that some surgeons have been using these drugs without proper regard for their chemical natures. It is well known that ordinary talcum powder, from the surgeon's gloves, causes adhesions.[1] Our work on dogs was started for the purpose of investigating whether or not the various sulfonamide preparations caused adhesions or other unfavorable intraperitoneal reactions.

## AUTHORS' EXPERIMENTS

We have performed eleven experiments on seven dogs. In three dogs we used sulfanilamide powder, in four sodium sulfathiazole, and later we used the first three dogs for our sulfathiazole experiments. The intraperitoneal reactions in these dogs were studied at two-, four- and eight-week intervals.

In the dogs in which sulfanilamide was placed in the peritoneal cavity and into the abdominal wall outside of the peritoneum, there was no evidence either after two, or after four weeks that any drug had been used: There were no adhesions, the omentum was free and not thickened; there were no traces of the powder, and there was healing per primum of the wounds without any induration.

After sulfathiazole had been used in these same dogs, again no adhesions appeared; the omentum was free, but there was moderate thickening at the base of the mesentery. Wound healing was not delayed, but in one of the dogs there was a moderate amount of serous discharge from the wound during the first three days.

In contrast to the above observations, the use of sodium sulfathiazole produced large masses of adhesions in all four dogs after two weeks as well as after four weeks. The omentum and the bowels were matted into a hard inflammatory mass. In two of the dogs this mass was firmly adherent to the abdominal wall. In these four dogs it was noted at the time of operation that, immediately after the sodium sulfathiazole had been placed into the wound, the peritoneal cavity became filled with fluid. The wounds of these dogs were characterized by much serous discharge, and in two of the dogs, by marked necrosis and sloughing of tissues in the abdominal wall. At the end of eight weeks there was some resolution of the inflammatory mass, but there were still many adhesions.

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